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International application number: PCT/AU05/000254

International filing date: 25 February 2005 (25.02.2005)

Document type: Certified copy of priority document

Document details: Country/Office: AU
Number: 2004900923
Filing date: 25 February 2004 (25.02.2004)

Date of receipt at the International Bureau: 15 March 2005 (15.03.2005)

Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b)

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Organisation Mondiale de la Propriété Intellectuelle (OMPI) - Genève, Suisse

PCT/AU2005/000254

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I, JANENE PEISKER, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. 2004900923 for a patent by JOHN WENTWORTH BUCKNELL as filed on 25 February 2004.

WITNESS my hand this
Seventh day of March 2005

JANENE PEISKER
TEAM LEADER EXAMINATION
SUPPORT AND SALES

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Regulation 3.2

AUSTRALIA

Patents Act 1990

PROVISIONAL SPECIFICATION

Invention Title: "HYDRAULICALLY ASSISTED FASTENERS AND HYDRAULIC TENSIONING DEVICES"

The invention is described in the following statement:

TITLE: HYDRAULICALLY ASSISTED FASTENERS AND HYDRAULIC TENSIONING DEVICES

BACKGROUND OF THE INVENTION

1. Field of the Invention

THIS INVENTION relates to hydraulically assisted fasteners and hydraulic tensioning devices. More particularly, the invention relates to hydraulically assisted fasteners and hydraulic tensioning devices operable to fasten one or more parts together. In alternative forms of the invention, the hydraulic fasteners may comprise a threaded nut or washer; while in a further form, the hydraulic tensioning devices may comprise tensioning rings particularly suitable for, but not limited to, closing flange joints on pipelines, valves and the like.

2. Prior Art

The use of fasteners employing hydraulically operated components to apply bolt tension is well established. Examples can be found in US Patent 5,730,569 (Bucknell) (= International Application PCT/AU93/00477 = International Publication WO 94/07042). Further examples can be found in the "References Cited" on US Patent 5,730,569.

Such fasteners are intended to be installed in a manner allowing their periodic removal for service or maintenance on the equipment to which they are fixed. Such fasteners are seldom used in situations where they may be permanently applied. Factors which discourage such usage are:

a) high initial cost compared to other methods; and

b) deterioration of hydraulic seal material over time or at elevated temperatures.

US Patent 5,730,569 proposes hydraulic fasteners which are elementally simple and therefor very inexpensive to produce. The

devices do, however, rely upon the preservation of seal integrity to maintain the tensile layers produced in the bolts on members to which they are affixed.

Because of the factors listed above, hydraulically assisted fasteners have not been used in the construction of sub-sea pipelines and conduits for the fixing of flange joints on pipelines, valves and the like. The current method requires divers to operate multiples of specially constructed hydraulic bolt tensioners simultaneously to close the underwater flange joints. The costs of such operations are quite extravagant as they require the engagement of an entire dive support vessel and crew, aswell as divers. Risk to personnel and equipment increase significantly with greater depth as does cost. As shallower fields are depleted, offshore oil and gas exploration, drilling and production move to deeper waters, and these factors become a significant factor in viability. Remote Operated Vehicles (ROVs) are used to perform complex bolting operations at depth where divers' bottom time is severely limited. Such machines are limited in their dexterity, and even more uncertain in delivering a satisfactory outcome when encumbered by lack of visibility or limited mobility. Currents and other local environmental factors also can cause havoc and blow out operating expenses massively.

SUMMARY OF THE PRESENT INVENTION

It is an object of the present invention to provide hydraulically assisted fasteners, or hydraulic tensioning devices, which operate without hydraulic seals, to directly tension bolts or members to which they are fixed.

It is a preferred object to provide such fasteners or devices which require no locking ring devices to secure the induced tensile load produced.

It is further preferred to provide such fasteners or devices which are not subject to degradation of seal material and may be used with a charging medium which will similarly not degrade under operating conditions of the selected operation.

Other preferred objects of the present invention will become apparent from the following description.

In one aspect, the present invention resides in a hydraulically assisted fastener including:

a connector body, with a bore therethrough to receive a connector element, having an annular recess opening axially outwardly of an end surface;

an annular thrust member, slidably and sealably engaged with the annular recess;

an annular chamber defined by the annular recess and the annular thrust member; and

a charging medium introducable into the annular chamber under pressure to move the connector body relative to the annular thrust member to tension the connector element, the charging medium being settable in the chamber to maintain the tension in the connector element.

Preferably, the connector element is a bolt or like fastener.

The connector body may comprise a nut, with a screw-threaded bore to operably engage the connector element, or a thrust washer, with a plain bore, to be placed below a nut on the connector element.

The annular recess may extend radially inwardly to the bore, and the chamber may be defined by the annular recess, the annular thrust member and the connector element.

The annular thrust member may be a piston, ring or thrust washer. The piston may incorporate an annular flange extending around,

and be slidably sealed to, the periphery of the connector body.

The connector body and/or the annular thrust member may incorporate integral deflecting and/or sealing lips to slidably seal the chamber.

The charging material may be a viscous paste which cures to become solid; suspended solids in a self-setting compound; or particulate solids which behave and flow as fluid media. By using a media exchanger, solid injectable media such as graphite may be used. Particulate solids of granular nature such as lead, copper or steel balls may be used.

In a second aspect, the present invention resides in a hydraulic tensioning device including:

a device connector body, with a plurality of bores therethrough to receive respective connector elements, having a plurality of device recesses, the device recesses opening axially outwardly of an end surface;

at least one device thrust member slidably and sealably engaged with the device recesses;

a respective device chamber defined by a device recess and the, or a respective, device thrust member;

at least one distribution gallery interconnecting the device chambers; and

a charging medium introduceable under pressure into the device chambers, via the distribution gallery or galleries, to move the device connector body relative to the or each device thrust member to tension the connecting elements, the charging medium being settable in the device chambers to maintain tension in the connector elements.

The bores in the device connector body are preferably plain; and may be inwardly convergent, to receive nut cone(s) to operably

connect the device connector body to the connector elements.

Preferably, each device recess is provided as an annular recess about a respective bore in the device connector body, and may be open radially inwardly to such bore.

In a modified embodiment, additional or alternative device recesses may be provided intermediate adjacent bores.

While it is preferable a respective thrust member maybe provided for each device recess, a single device thrust member may be used.

The device connector body and the device thrust member(s) may comprise annular rings in plan view for the joining of flange joints, eg., for pipelines, valves or the like. (The device thrust members may be respective thrust washers about each connector element.) However, the skilled addressee will appreciate that the device connector body and the device thrust member(s) may be square, rectangular, hexagonal or of polygonal shape; circular, elliptical or other regular or irregular shape in plan view to suit the particular intended application.

BRIEF DESCRIPTION OF THE DRAWINGS

To enable the invention to be fully understood, preferred embodiments will now be described with reference to the accompanying drawings, in which:

FIG. 1 is a top plan view of a hydraulically assisted fastener in accordance with a first embodiment of the invention;

FIG. 2 is a schematic sectional side view thereof fitted to a connector element;

FIG. 3 is an isometric view of a hydraulic tensioning device, in accordance with the present invention, fitted to a flange joint;

FIG. 4 is an "exploded" view of the assembly of FIG. 3;

FIG. 5 is a view, on a larger scale, corresponding to a

portion of FIG. 4;

FIG. 6 is a sectional side view showing the charging of the hydraulic tensioning device;

FIG. 7 is a sectional side view showing the charging of another embodiment of a hydraulically assisted fastener; and

FIGS. 7 and 8 are sectional side views of alternative internal configurations of the fastener of FIG. 7.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIGS. 1 and 2, the hydraulic fastener 10, in accordance with a first embodiment of the invention, is screw-threadably engaged with a connector element, in the form of a bolt 20, engaged in, or passing through, a part P to be held under tension.

The fastener 10 has a connector body 11 with a screw-threaded bore 12 therethrough to engage the complementary threads 21 on the bolt 20. The connector body 11 is profiled (with six flat faces 13) to enable engagement with a suitable tensioning tool. (The external profile of the connector body 11 can be varied to suit the different types of tensioning tools employed.)

An annular recess 14 is formed in the connector body 11 and is open axially towards an end face 15 and radially inwardly to the bore 12 of the connector body.

As shown, the lower portion of the connector body 11 has a peripheral skirt 16 which surrounds the annular recess 14.

A thrust member, in the form of an annular thrust washer 17 is slidably, sealably received in the annular recess 14 and has a curved upper face 18.

An annular chamber 30 is defined by the annular recess 14 in the connector body 11, the thrust washer 17 and the outer face of the

bolt 20.

A nipple 40, with a one-way valve 41, is screw-threadably engaged in the peripheral skirt 16 of the connector body 11 and is connected to the annular chamber 30 by a passage 31.

The nipple 40 is operably connectable to a source which enables a charging medium 50, such as a particulate solid, to be injected through the nipple 40 into the annular chamber 30 under pressure to expand the working volume of the annular chamber 30.. The connector body 11 moves in a relative direction opposite the thrust washer 17 to apply tension to the bolt 20.

When the required tension has been applied to the bolt 20, the source of the charging medium 50 is disconnected from the nipple 40 and backflow of the charging medium 50 through the nipple is prevented by the one-way valve 41.

As hereinbefore described, the charging medium 50 may be of viscous paste which cures to become solid; suspended solids in self-setting compound, or particulate solids which behave and flow as fluid medium. If the source of the charging medium incorporates a media exchanger, solid injectable media such as graphite may be used. Particulate solids of granular nature such as lead, copper or steel balls may be used in the charging materials 50. The charging medium 50 is settable and forms a solid block which prevents movement of the connector body 11 relative to the thrust washer 17, so as to prevent any reduction in the tension applied by the hydraulic fastener 10 to the bolt 20.

By use of the settable charging medium 50, the need for the seals between the thrust washer 17 and the adjacent contact wall of the annular recess 14 in the connector body is avoided. Therefore, the possibility of reduction in applied tension to the bolt 20, due to seal

deterioration, is avoided.

Referring to FIGS. 2 to 6, a hydraulic tensioning device 110, in accordance with a second embodiment of the present invention, is used to join the pipe flanges PF1, PF2 of respective pipes P1, P2 at a flange joint.

For ease of manufacture, the hydraulic tensioning device 110 has a device body, in the shape of an annular ring formed of upper and lower connector body parts 111, 112.

The upper connector body part 111 has a plurality of downwardly convergent bores 113 therethrough to receive a respective bolt 120 extending above the pipe flange PF1. Each conical bore 113 is adapted to receive a trifurcated nut cone 122 operable to engage the screw-threads 121 on its respective bolt 120. The trifurcated nut cone 122 is prevented from escaping from the conical bore 113 by at least one spring clip 123. The lower connector body part 112 has a bore therethrough, of larger diameter than the bore 113 to form, with the upper body part 111, an annular recess 114 adapted to receive a respective thrust washer 117 so that the upper and lower connector body parts 111, 112, the thrust washer 117 and the bolt 120 form a respective annular chamber 130 to receive the charging medium 150 in the manner hereinbefore described.

Each annular chamber 130 which surrounds a respective bolt 120 is interconnected by one or more distribution galleries 151 extending around the connector body and provided in the upper and/or lower connector body parts 111, 112.

By manufacturing the connector body in two parts, the distribution gallery(ies) 151 can be machined and then the upper and lower connector body parts 111, 112 can be secured together by a plurality of joining bolts 119.

As illustrated in FIG. 6, the charging medium 150 is injected, under high pressure, using a media exchanger 160 (to be hereinafter described in more detail) which is screw-threadably engaged in passage 131 connected to a distribution gallery 151 where the passage 131 is closeable by a non-return valve 141, which operates in the manner of the non-return valve 41 in the nipple 40 of the embodiment of FIGS. 1 and 2.

The media exchanger 160 has a body 161 which is connected to a source of hydraulic oil 162 via a hydraulic line 163. The hydraulic oil 162 is forced into the media exchanger 160 under pressure to cause a separator piston 164 to move in the body 161 of the media exchanger 160 to cause the (particulate solid) charging medium 150 to be expelled from the media exchanger 160, to thereby cause the effective volume of the annular chambers 130 to expand and thereby move the connector body (111, 112) relative to the respective thrust washers 117 to cause the bolts 120 to be tensioned to the desired level.

When the desired tension has been achieved in the bolts 120, the media exchanger 160 is disconnected from the passage 131 and the non-return valve 141 prevents the release of the charging medium 150 from the hydraulic tensioning device 110. The charging medium 150, of the type hereinbefore described, sets to prevent relative movement of the connector body (111, 112) to the thrust washers 117 to prevent a reduction in tension applied by the hydraulic tensioning device 110 to the bolts 120.

It will be readily apparent to the skilled addressee that manufacture of the hydraulic tensioning device 110 is relatively simple and inexpensive, given that no complex operation or tooling is required. The upper and lower parts 111, 112 of the connector body are bolted together by the bolts 119 to encapsulate the distributor gallery 151, so

that no intricate drilling operations are required. Each trifurcated nut 122 is inserted in its respective conical bore 113 and retained with the spring clip 123 which provides both retaining and closing forces for the nut assembly 122.

In operation, the hydraulic tensioning device 110 is fitted over the bolts 120 protruding from the pipe flange PF1, as shown in FIG. 4. The action of pushing the hydraulic tensioning device 110 over the bolts 120 allows the cone nuts 122 to ratchet over the bolt threads, and eliminates the need to screw nut components into place.

As hereinbefore described, the charging medium 150 can flow to each annular chamber 130 via the distributor gallery 151, forcing the thrust washers 117 to react against the adjacent pipe flange PF1, thereby creating tensile forces which are evenly and simultaneously distributed to each bolt 120. At a predetermined pressure, the correct load will be achieved in each bolt 120. The one-way valve 141 will automatically activate and the pressure pumping apparatus can be removed, with full pressure remaining in the assembly.

Where setting paste is used as the charging medium 150, this will rapidly cure, preventing any leakage and subsequent loss of tensile load on the bolts 120. In the instance of a particulate solid being used as the charging medium 150, this media will retain the tensile load indefinitely, as it is already at a high density.

FIG. 7 illustrates a third embodiment of the present invention where a standard form of hydraulic nut 210 is charged with the charging medium 250, using a media exchanger 260, in the manner hereinbefore described with reference to FIGS. 3 to 7. In this instance, the pressure of the charging medium 250 is not required to be maintained, as the generated force is retained via a locking ring 216, screw-threadably engaged on the nut body 211 and engageable with the

piston 217 (which co-operates with the nut body 211 to form the annular chamber 230). When this type of hydraulic nut 210 is required to be removed intact at some later time, the charging medium 250 used will be of a flowable nature in order to assist with re-pressurisation for loosening of the lock ring 216.

Due to the nature of the charge medium 250 used, the sealing capacity of the fasteners 10, 210/tensioning devices 110 need only be rudimentary. As illustrated in FIGS. 8 and 9, leading edges of components and sliding engagement may be altered in order to enhance the sealing ability for the use of viscous materials as the charging media 250.

The use of the charging medium 50, 150, 250, and in particular, the use of solid injectable media (such as graphite) and the particulate solids of granular nature, (such as steel balls), will allow the hydraulic tensioning fasteners and hydraulic tensioning devices of the present invention to be used in high temperature applications. In such cases, it may be desirable to use the hydraulic nut of FIGS. 7 to 9, having a locking ring 216, to retain the desired load. Removal of the fastener 210 would require injection of the charging medium 250, loosening of the locking ring 216, release of pressure and subsequent unscrewing of the device 210 from the bolt 220.

Various changes and modifications may be made to the embodiments described and illustrated without departing from the present invention.

DATED this twenty-fifth day of February 2004.

JOHN WENTWORTH BUCKNELL

By his Patent Attorneys

FISHER ADAMS KELLY

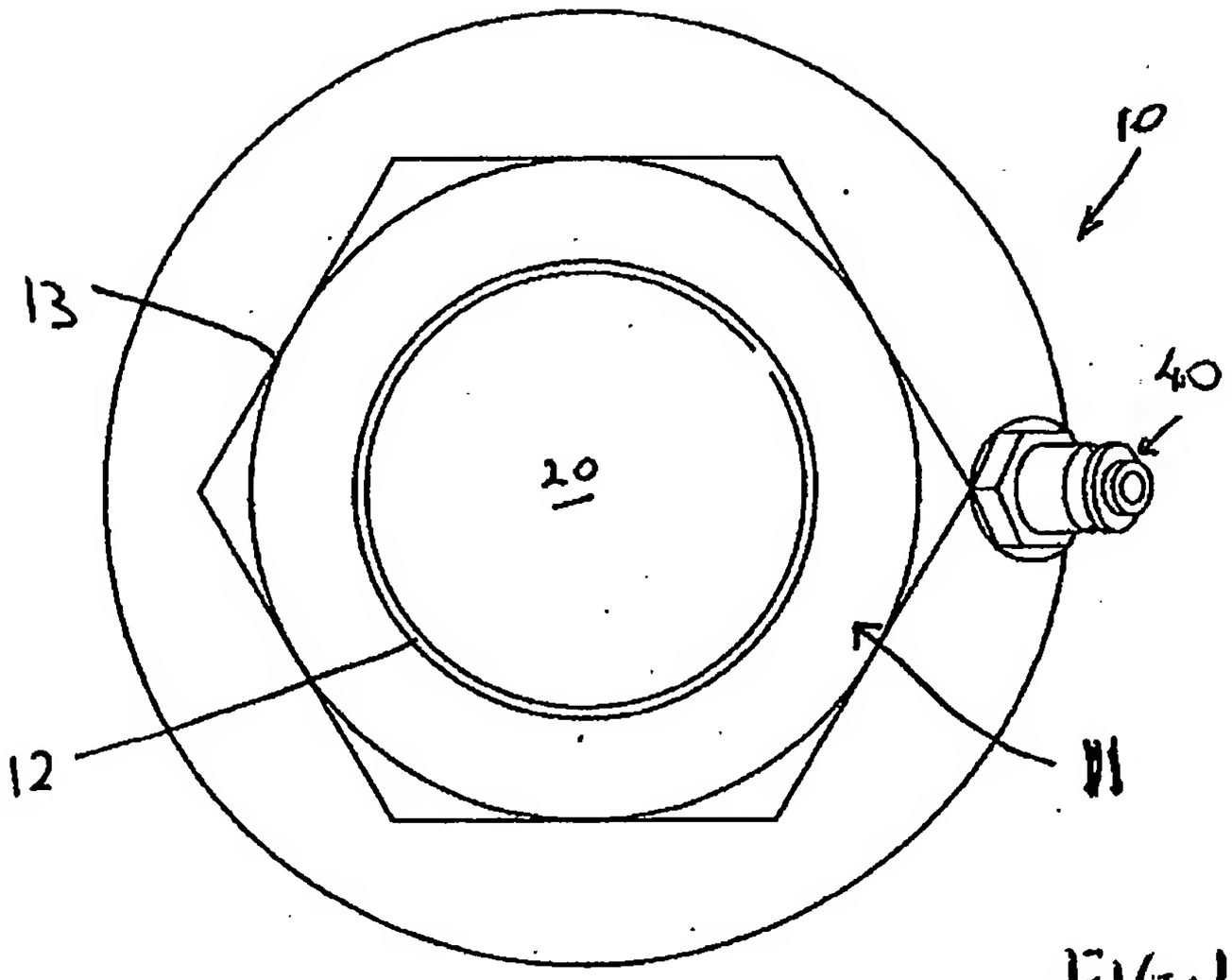

FIG. 1

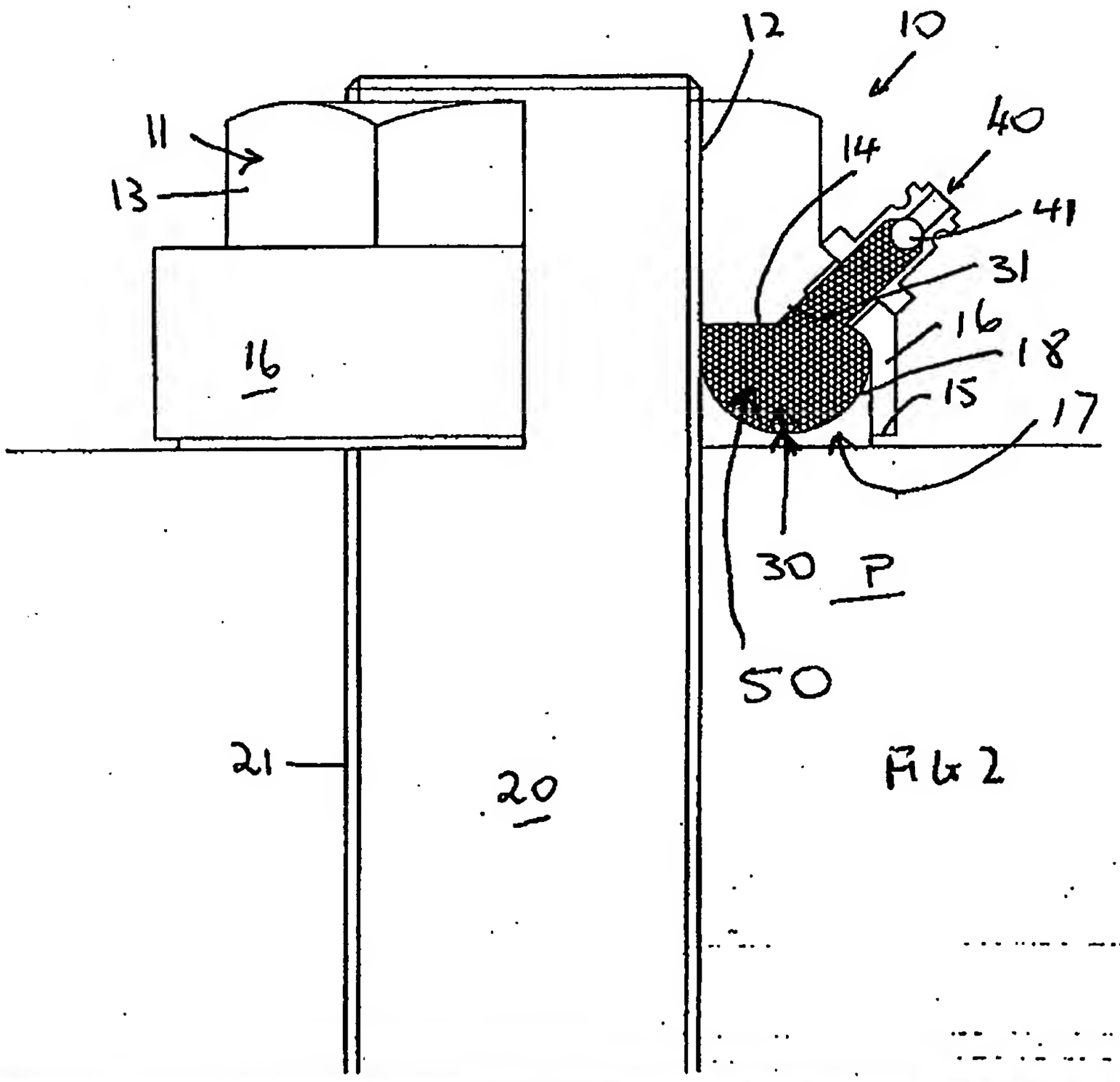

Fig 2

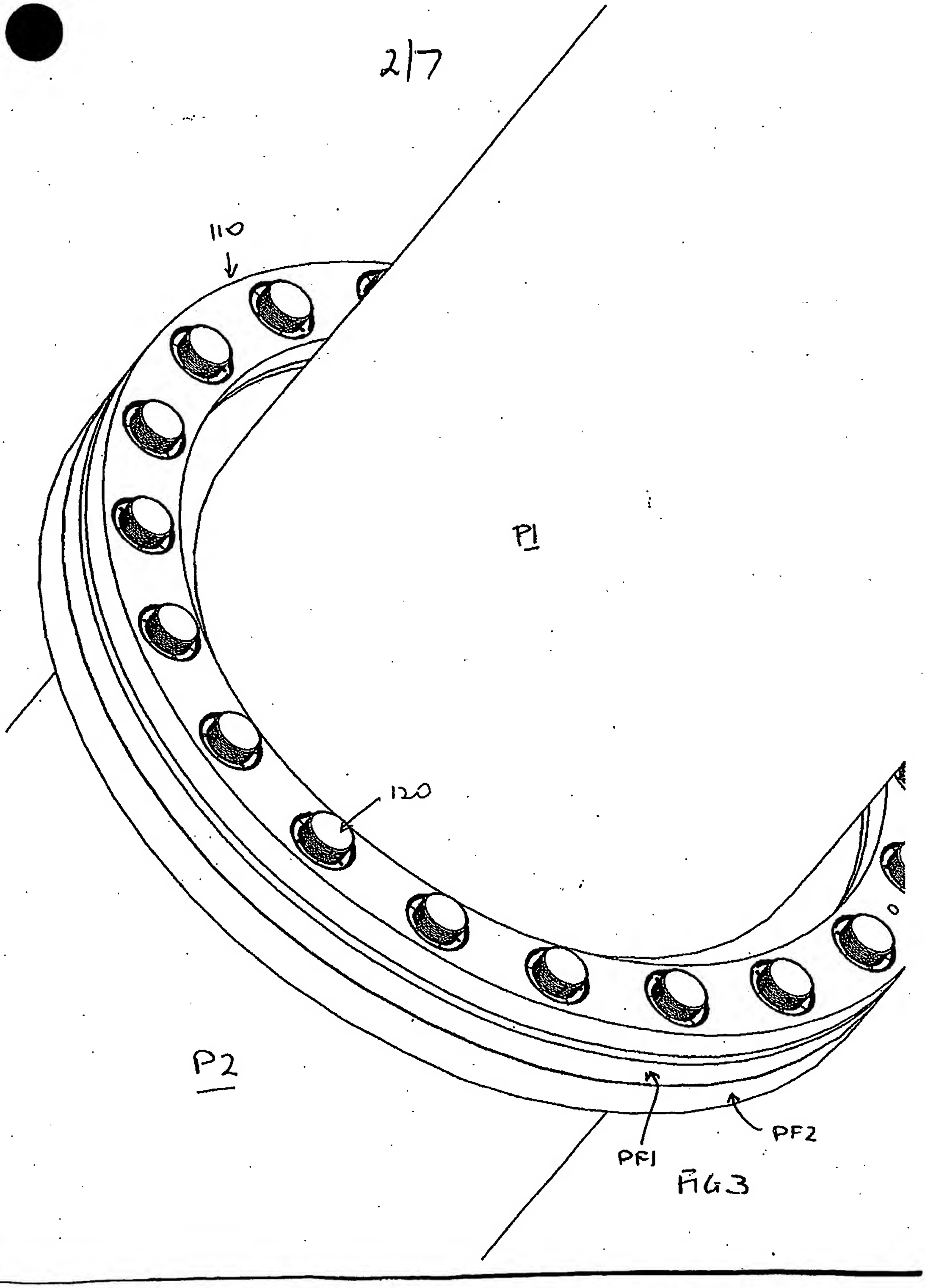

FIG 3

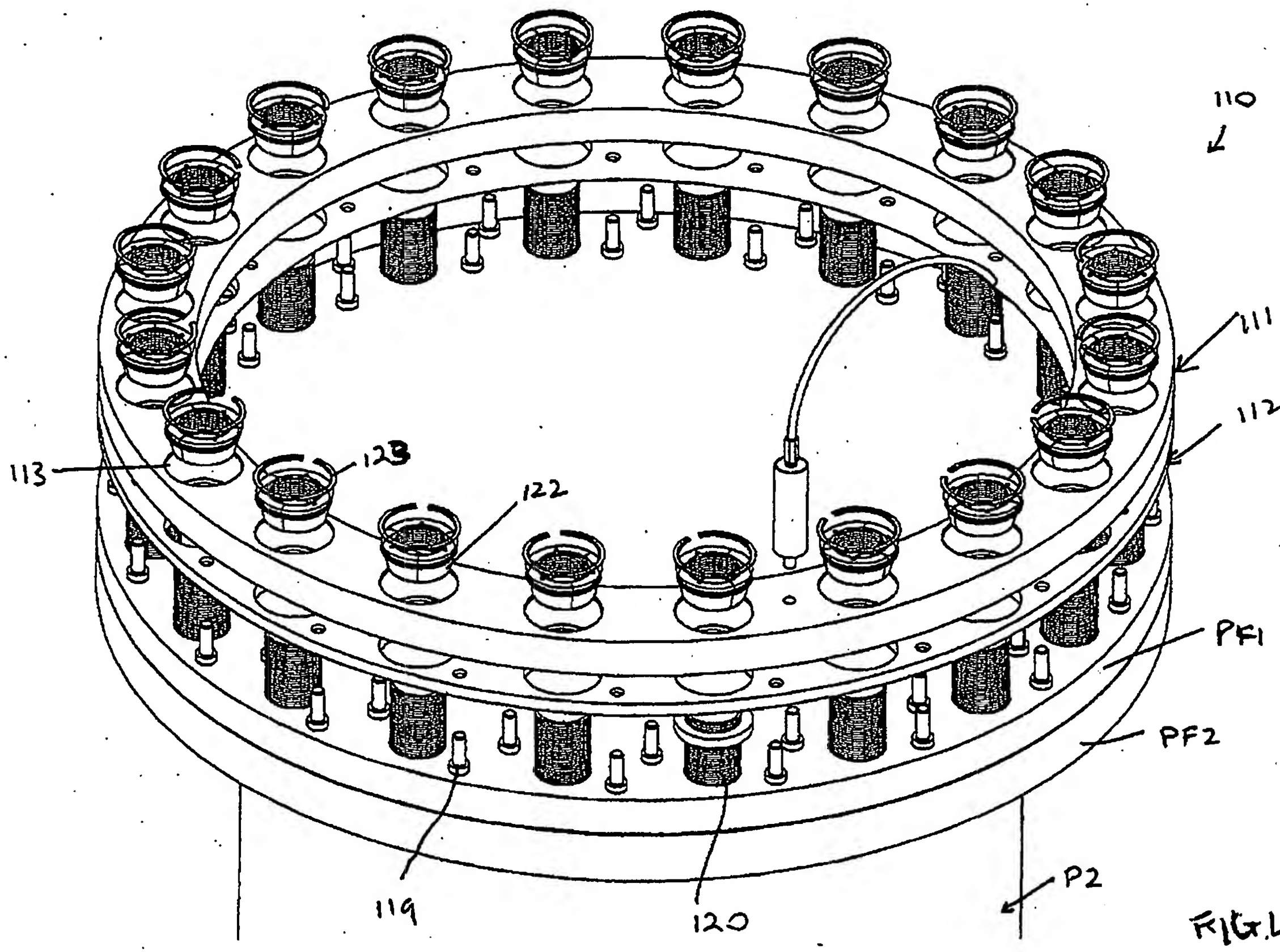

FIG.4

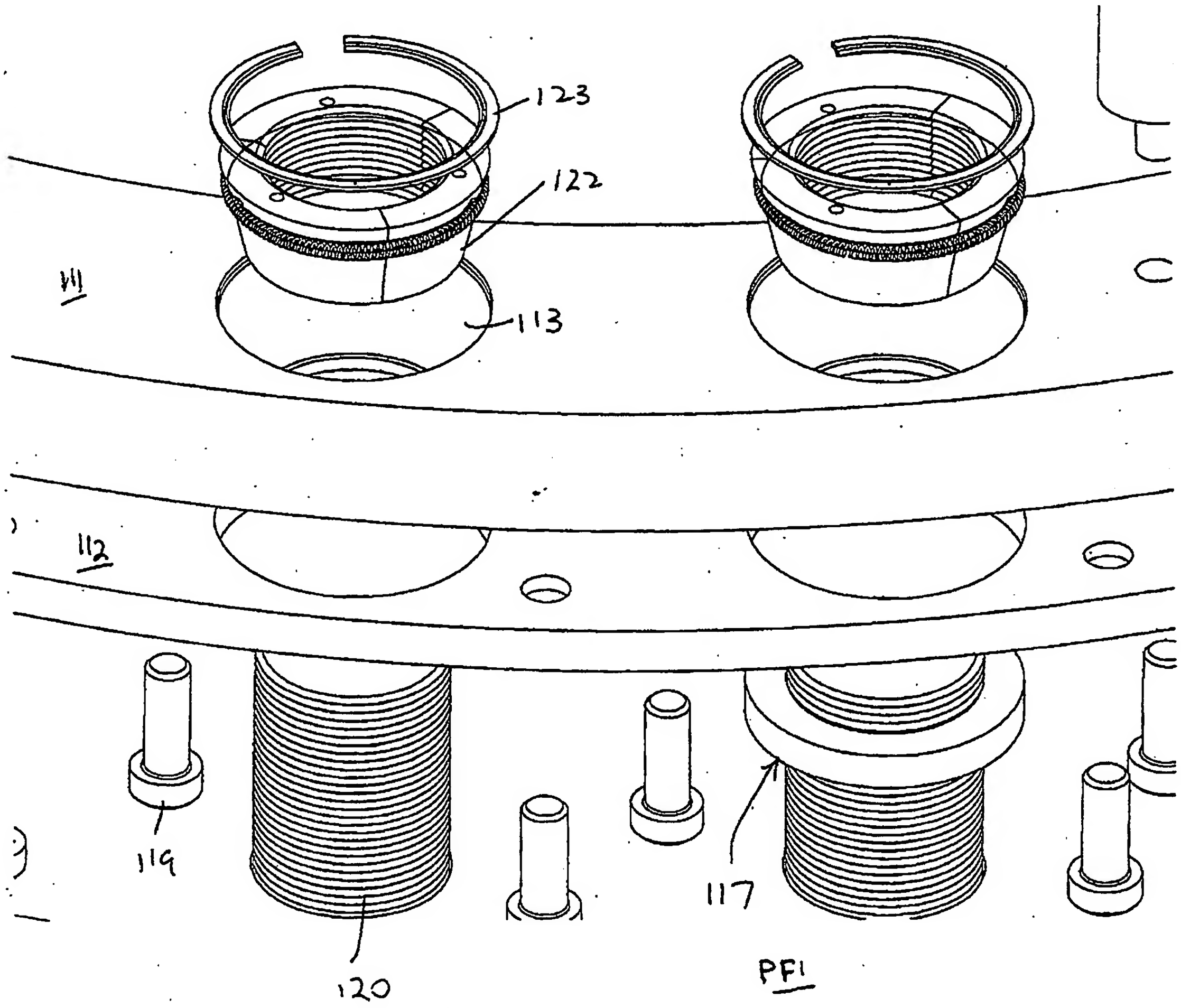

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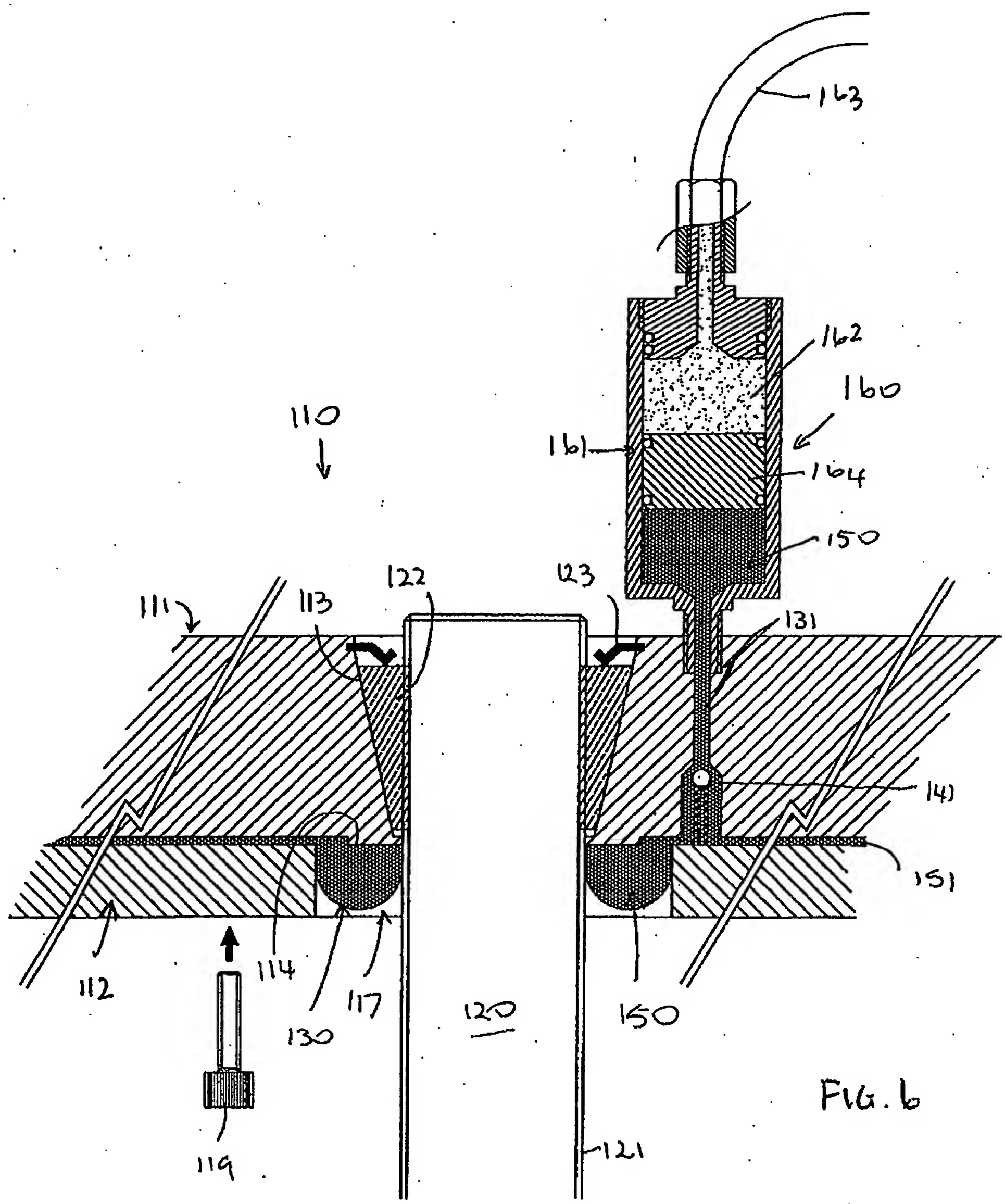
FIG. 5


163
162
160
161
164
150
110
122
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111
113
131
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151
112
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117
120
130
150
119
121

FIG. 6

617

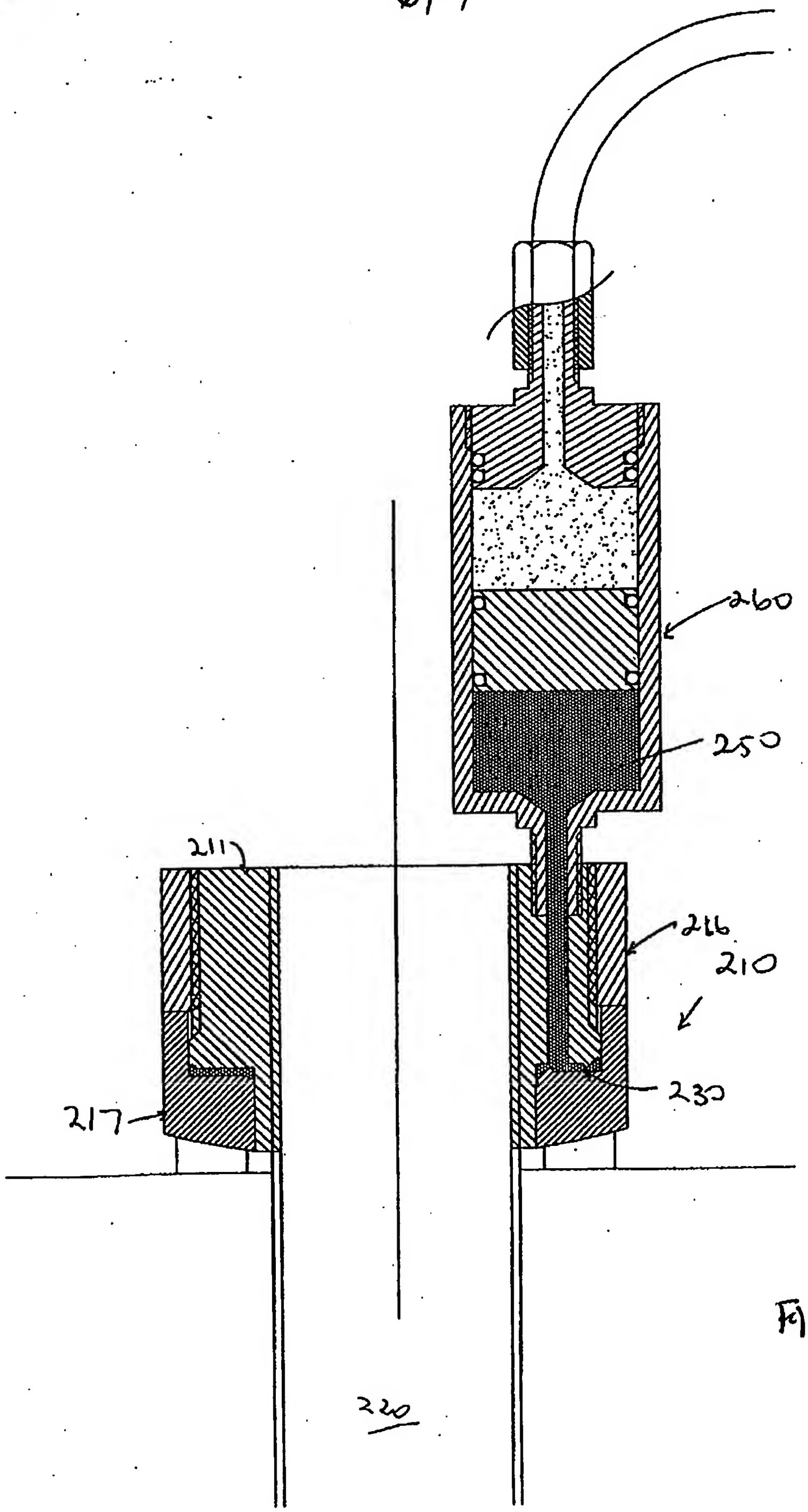

FIG.7

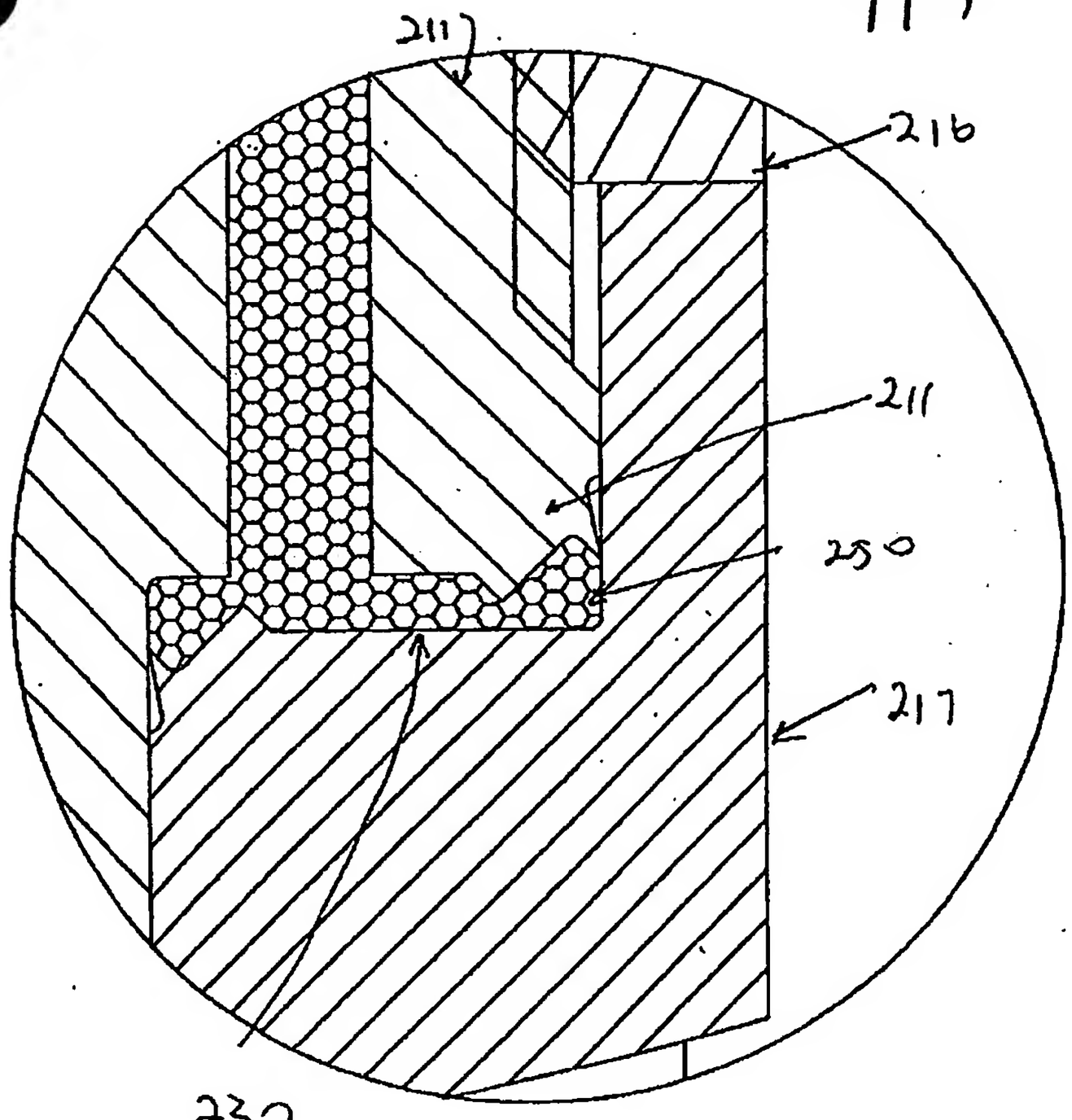

FIG8

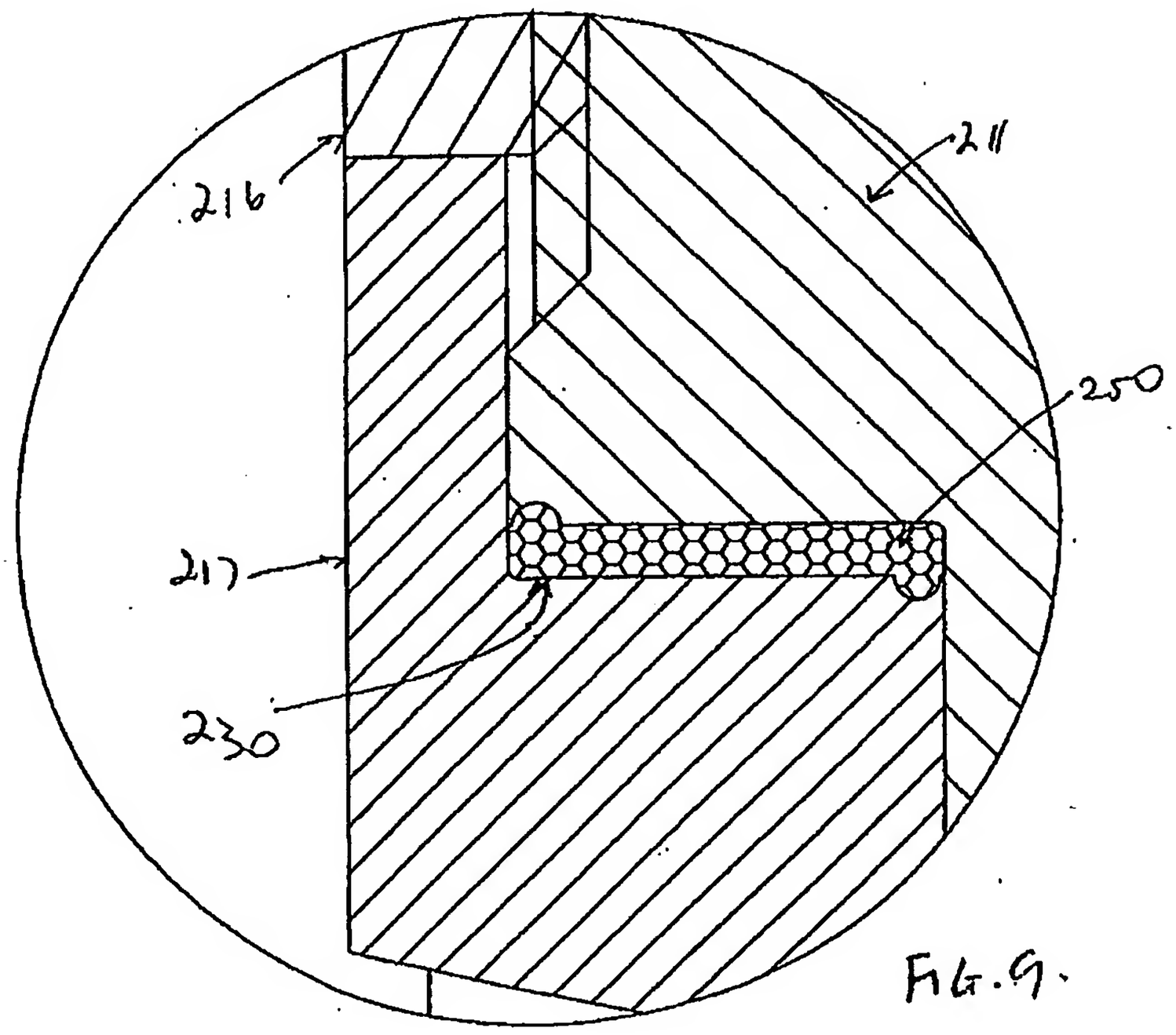

FIG.9.